

# PATENT SPECIFICATION

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## COMPLETE SPECIFICATION

### Method of Removing an Electrically Conducting Film

We, LIBBEY-OWENS-FORD GLASS COMPANY, a Corporation organized under the laws of the State of Ohio, of 608 Madison Avenue, City of Toledo, County of Lucas and State of Ohio, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates broadly to electrically conducting metal oxide films and more particularly to a method for removing selected portions of such films from surfaces to which they have been applied.

Transparent, electrically conducting films of tin oxide, for example, are quite widely known; and such films have come into rather extensive commercial use in connection with the production of deicing windows and windshields of aircraft. Such a film may be obtained by spraying the glass, while heated to substantially its point of softening, with tin tetrachloride or other suitable tin compounds to produce a film primarily of a tin oxide which is electrically conducting. One of the characteristics of these films is their extremely tight adherence to vitreous surfaces, like glass, when applied thereto. In fact, it has been said that a properly applied electrically conducting coating of tin oxide on a glass sheet is very nearly as hard and as difficult to remove as the glass surface itself.

Nevertheless, it is very often necessary in the production of glass articles provided with such a film to remove selected strips or areas of the film to facilitate testing of the unit, to improve its appearance or utility, or to control or regulate the conductivity of the filmed surface.

The present invention is particularly applicable in providing a plurality of areas of electrically conducting films which are separated by nonconducting areas which are in the form of thin lines.

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It is a primary object of this invention to provide a method of removing films of the above character quickly and without injury to the supporting surface.

Another object of the invention is the provision of a method of removing such films in the form of a narrow line by electrical means in which the removal may be done accurately and quickly and in which the line removed is of a uniform width throughout.

In the accompanying drawings:

Fig. 1 is a diagrammatic showing of a preferred form of the method in which my invention may be carried out; and

Fig. 2 is a perspective view illustrating a sheet of glass having a transparent electrically conducting film in which lines have been deleted therefrom according to this invention.

According to the present invention, there is provided a method of removing an electrically conducting metal oxide film from glass or ceramic material, comprising coating the metal oxide film with an organic liquid, establishing a voltage between an electrode and the metal oxide film sufficient to produce an arc through the organic liquid, and contacting the organic liquid overlying the metal oxide film with the electrode.

Generally stated, the invention is based on the discovery that an electrically conducting film may have a portion thereof deleted in the form of a line by coating the film with an organic liquid, applying an electric potential between the film and an electrode, and contacting the electrically conducting film with the electrode. In order to remove the film in the form of a line it is only necessary to move the electrode over the electrically conducting film at a writing speed. It is not known exactly how the deletion is accomplished, but it is believed that the organic liquid acts as a dielectric and that an arc travels therethrough due to the electric potential between the electrode and the

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electrically conducting film. This arc probably causes a decomposition of the organic material in which hydrogen is formed or at least reducing conditions are provided so that the tin oxide film is reduced to metallic tin. The remaining metallic tin is substantially nonconducting but, if desired, it may be removed with a dilute acid solution.

In Fig. 1 there is shown a light of glass 10 having an electrode or bus bar 11, which may consist of a fired-on silver frit, and an electrically conducting film 12 of a metal oxide and preferably tin oxide. In order to remove a portion of the electrically conducting film 12 a layer of an organic liquid 13 such as glycerin is brushed, sprayed or otherwise applied over the film 12. A carbon electrode 14 is sharpened to a point 15 having a width corresponding to the desired width of the line of material to be deleted. In fact, an ordinary graphite pencil may be used having a rod for the electrode 14 and a wooden case 16 which encloses the electrode 14. Preferably, a direct current is used, and the carbon electrode is connected to the positive post through lead wire 17, and the bus bar or fired-on silver electrode 11 is connected to the negative post of the direct current supply through lead wire 18. However, the film may be deleted when the electrical connection is in the reverse of that given or even when an alternating current is applied. After the electric potential has been connected, the carbon electrode is placed in contacted position, as shown in Fig. 1, and moved over the surface 12 to form a line of deleted electrical conducting film in the desired pattern.

Generally, any organic liquid may be used, but some are superior to others. For example, light oil may be used, but it is not so easily removed as glycerin. Other operable materials may have disagreeable odors or create a fire hazard or for other reasons be inferior to glycerin, but it is to be understood that such materials may be used in the practice of this invention. Preferably, carbon is used for the electrode although other materials may be used. However, carbon has the advantage of being easily sharpened to the desired width.

The voltage must be sufficient to produce an arc through the organic material, but excessive voltages should be avoided due to excessive temperatures produced thereby. Preferably, the voltage used is between 25 and 100 volts.

In Fig. 2, there is shown a light of glass having lines 19 deleted thereon to form separate areas 20, 21 and 22 of electrically conducting film. Such lights of glass are used in the aircraft industry and the illustrated shape is often used. In such cases, the whole light is filmed with tin oxide to provide a light of a uniform appearance. The lines 19 are narrow enough so that the uniform appearance

is maintained while at the same time the area 21 is uniformly heated to prevent frost formation or remove the same in the critical area. Lights having portions deleted therefrom are also proposed for use in automobiles.

It is contemplated that other uses may be made of the present deletion method, and it is to be understood that the use illustrated in Fig. 2 is not to be construed as the only use to which this method is applicable.

Although this method of deleting a portion of an electrically conducting film is particularly valuable in deleting an area in the form of a line, it is to be understood that other areas may be deleted simply by moving the carbon electrode to delete juxtaposed parallel lines so that an area of unlimited width may be formed, or that a line may be formed in such a way that an area is enclosed within the line which is completely set off from the main electrically conducting film. It has been found that a line may be traced in the form of a circle and that the resistance between the film on the inside of the circle and the film outside the circle is in the range of megohms. Accordingly, areas may be deleted as well as lines.

#### WHAT WE CLAIM IS:

1. A method of removing an electrically conducting metal oxide film from glass or ceramic material, comprising coating the metal oxide film with an organic liquid, establishing a voltage between an electrode and the metal oxide film sufficient to produce an arc through the organic liquid, and contacting the organic liquid overlying the metal oxide film with the electrode.

2. A method of removing an electrically conducting metal oxide film as claimed in claim 1, in which the metal oxide is a tin oxide.

3. A method of removing an electrically conducting metal oxide film as claimed in claims 1 or 2, in which the organic liquid is glycerin.

4. A method of removing an electrically conducting metal oxide film as claimed in any of claims 1 to 3, in which the voltage established between the electrode and the film is between 25 and 100 volts.

5. A method of removing an electrically conducting metal oxide film as claimed in any of claims 1 to 4, in which the electrode is moved lineally over the surface of the organic liquid.

6. A method of removing an electrically conducted metal oxide film as claimed in any of claims 1 to 5, in which the direct current voltage is used with the electrode being connected to the positive terminal and the metal oxide film being connected to the negative terminal of the direct current source.

7. A method of removing an electrically conducting metal oxide film from glass or

ceramic material substantially as hereinbefore described.

LEWIS W. GOOLD & CO.,  
Chartered Patent Agents,  
5, Corporation Street,  
Birmingham, 2.  
Agents for the Applicants.

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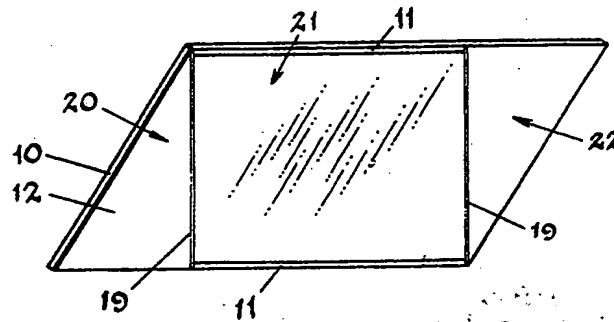
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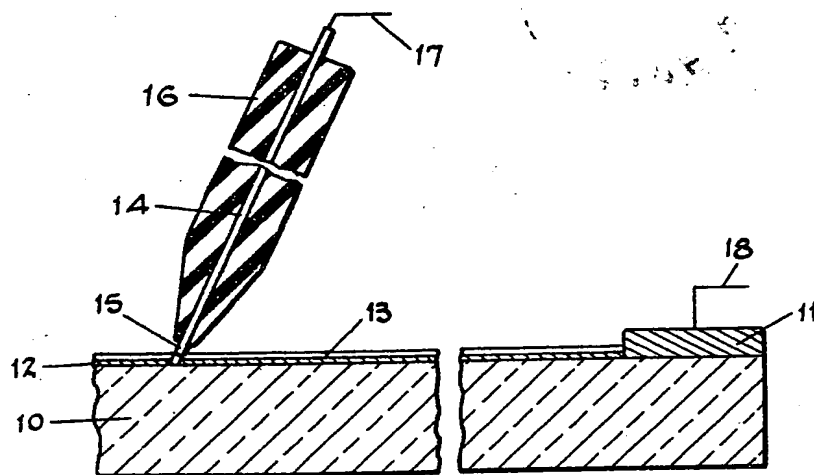
COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of  
the Original on a reduced scale.



*Fig. 2*



*Fig. 1*